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Topics

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RADIATION

and

ALCOHOLISM

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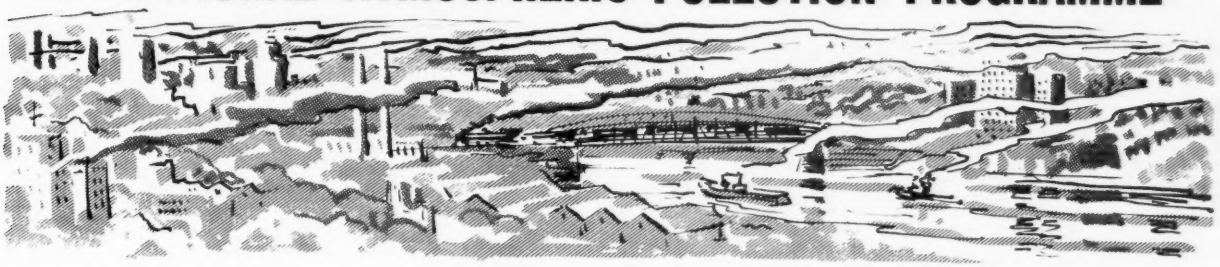
The cover illustration shows a compressed-air-driven high volume filter paper sampler used to collect air samples for free silica analysis during a survey of Newfoundland fluorspar mines in October 1956.

A NATIONAL ATMOSPHERIC POLLUTION PROGRAMME



by

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1. Introduction

Atmospheric pollution with its unpleasant and harmful effects on public welfare and property represents a growing problem in Canadian urban and industrial communities. The public is now well aware of the importance of controlling harmful and excessive emissions which may create acute effects on health under unfavourable meteorological conditions. Although no smog disasters have been reported in Canada, widespread publicity has brought home the knowledge of such episodes as the Meuse Valley, Donora, Poza Rica and London smog disasters, and the perennial problem of eye irritation, reduced visibility and vegetation damage in Los Angeles County.

Interest in atmospheric pollution on the federal level is reflected in the activities of some Divisions in the Department of National Health and Welfare, in the Windsor-Detroit studies under the terms of a Reference to the International Joint Commission, and in advisory services to Federal and Provincial Departments. Enquiries come forward at an increasing rate in requests for general or detailed information on specific problems which are beyond the limited facilities of many municipal or provincial agencies.

The Occupational Health Division for a number of years has been conducting fundamental studies in laboratory procedures in the fields of analytical chemistry, physics and microscopy, relating to the measurement and identification of various contaminants and in toxicological effects. More recently an investigating group has been established to study the physical chemistry of various gases and vapours absorbed on aerosols and to determine the biological effects of various toxic systems in their joint action.

Since January 1st, 1956, certain responsibilities in connection with atmospheric pollution have been assumed by the Department of National Health and Welfare, with the establishment of advisory and other services under a consultant. Studies of a fundamental nature formerly carried on under the auspices of the International Joint Commission, are to be continued. This includes research on improvements in methods of sampling, analysis and separation of specific contaminants; studies of the nature and composition of urban and smog components; and the correlation of contaminant levels with meteorological factors. Other aspects of Departmental services involve trained staff and facilities in cooperation with provincial health departments for epidemiological studies of the health effects of urban pollution with improvements in methodology as suggested by the results of the Windsor-Detroit pilot study.

An increase in national interest in atmospheric pollution is indicated by the studies now in progress in this field under the Canadian Standards Association, the Ontario Research Foundation, and various other agencies. Over the past two years an extensive enquiry has been undertaken by the Select Committee of the Ontario Legislature on the nature of the problem and its control. Provincial departments are engaged actively in the investigation and control of specific problems in many industrial areas across Canada.

Pollution problems will multiply in scope and complexity in the future with continued growth of urban communities and expansion of industrial operations. Guidance will also be required in dealing with control of pollution from transportation sources such as the Great Lakes and St. Lawrence Seaway vessel traffic, the railroads and highway traffic.

With the approaching end of our hydro-electric power resources in some areas, large power plants will utilize conventional fuels such as coal, oil and natural gas. These will create problems from emission of sulphur dioxide, smoke and dust unless properly controlled. Atomic energy derived from uranium and other atomic fuels will be utilized on an increasing

scale for generation of electric power. Such plants will have to be carefully designed to control radioactive particulate and other emissions, and a continuing field check will be necessary to determine the radiation hazard, if any. It is anticipated that there will be a growing need for advisory services in connection with such developments.

A knowledge of the nature of atmospheric pollutants and the factors involved in diffusion and dispersion would be useful to agencies concerned with town planning, zoning, and community development in order to provide for better living conditions by proper distribution of industrial, commercial and residential areas interspersed with zones free from sources of contaminants.

2. Current Studies and Advisory Services Within the Department of National Health and Welfare

(a) Greater Windsor-Detroit Area

For several years, valuable assistance has been rendered to the International Joint Commission by the Divisions of Occupational Health, Epidemiology and Research and Statistics, in cooperation with the U.S. Public Health Service, in the study of the effects of urban pollution on sickness experience and morbidity rates of sample population groups in high and low pollution areas of the Detroit River region. The field investigations for this health study were organized under the Federal Health Grants Service with participation by the Ontario and Windsor Health Departments. Some of the findings were reported at the Annual Meeting of the Canadian Public Health Association, Saint John, N.B., in May 1956. Although no relationship was found between existing levels of air pollution and health on the basis of data gathered from household sickness surveys, valuable experience has been gained in methodology for future guidance in further studies of this problem.

Studies of the nature, composition and extent of pollution from major sources in this heavily industrialized area, initiated about six years ago under the terms of a Reference submitted to the International Joint Commission in 1949, have been completed. The work has involved the continuous measurement of sulphur dioxide, air-borne particulate matter, dustfull and other components of urban pollution in correlation with meteorological factors at networks of sampling stations. A large number of inorganic and organic compounds have been identified in the suspended dust, including some polynuclear aromatic hydrocarbons of known carcinogenic potency. Since 1952, a major improvement has been effected in smoke conditions from the large vessels, through the operation of a voluntary control regime. The findings, recommendations for control and remedial measures will be presented in a final report to the Commission which is now in course of preparation.

Planning and supervision of this work has been in the hands of a joint Canadian and United States Technical Advisory Board of four members of each side. Three of the Canadian Members are senior officers of the Department of National Health and Welfare.

(b) Yellowknife Area

Since 1949 an investigation has been in progress on the problem of pollution of the air and water supplies by arsenic from smelting operations of gold mines in this area. The work has been carried out by staff of the Laboratory Services, Occupational Health Division, in a continuing programme to assess the general hazard to public health from arsenic levels in water supplies, in vegetation and in dustfall. A close check is maintained on stack emissions, on the efficiency of arsenical dust collection equipment and on seepage from ponds for the storage of wet sludge containing arsenic.

Map of Greater Windsor-Detroit area.

(c) Consultant and other Services

Requests for assistance and advice have been coming forward at an increasing rate from the Health Departments of the Western Provinces. Visits have been made to various industrial areas in Manitoba, Alberta, and Nova Scotia and to Vancouver, B.C. These have dealt with problems arising from operations of the oil refining industry, operation of diesel equipment in mines, manufacture of bentonite, fluoride and other emissions from phosphate fertilizer and aluminium plants, chlorine emission and vegetation damage from a caustic soda plant, dust emission from blast furnace operations in the steel industry, assessment of the hazard from sulphur dioxide and other

waste products in nickel smelting; and the planning of surveys of urban pollution.

A programme has been initiated on the standardization of techniques in atmospheric sampling and analysis. This is being coordinated with activities of Committees of the American Society for Testing Materials, the Air Pollution Control Association and the Canadian Standards Association.

Assistance is being rendered to the Board of Transport Commissioners in the revision of regulations governing the control of atmospheric pollution from railway operations.

(*d*) *Biological Research*

The Research Group of Laboratory Services, Occupational Health Division, is investigating certain hypotheses which have been advanced by various scientists to account for the surprisingly great irritant and toxic properties of polluted urban atmospheres which have led to such disasters as those of the Meuse Valley, Belgium, in 1930; Donora, Pa. in 1948; and London in 1952. Eye irritation is a feature of the persistent Los Angeles smog problem, and is encountered on occasion in the Windsor-Detroit area, in Sarnia, Ont., and elsewhere.

The design and construction of a new type of flexible, dynamic, gassing chamber, with appropriate control devices and measuring equipment has been completed recently for studies of the biological effects of contaminants of the polluted urban atmosphere. In these experiments, both single and multi-component systems of gases and aerosols are being tested to determine the influence of solubility, adsorption and synergistic factors.

(*e*) *Health Study—St. Vincent's Hospital, Ottawa*

A study of the symptoms and sicknesses of aged patients at this hospital as influenced by fluctuations in air pollution concentration levels was undertaken in the summer of 1956 by the Epidemiology Division in cooperation with Occupational Health, and Research and Statistics, Divisions. Although previous studies in the Windsor area showed no significant differences between high and low pollution areas for the normal sample population, it was felt that the results were influenced considerably by uncontrolled variables and that observations on a distressed group would be more fruitful. The subjects chosen in the present study at St. Vincent's Hospital are patients suffering from some form of chronic respiratory or cardiovascular disease, with certain persistent symptoms.

It is hoped to determine whether there is any direct relationship between atmospheric pollution levels and the severity of these symptoms, taking into consideration such influencing factors as temperature, humidity, precipitation and other weather elements.

3. A Proposed Programme for Canada

A comparable effort to that of the United States, bearing in mind the differences in population and industrial development, would involve an expansion of existing facilities to deal with projects along the following lines:—

1. Direct research and investigational work involved in the establishment of a national air sampling network of stations on a cooperative basis.
2. Grants-in-aid to the provinces and other assisted projects in connection with studies of the effects of urban and industrial pollution on public health and welfare, assistance to Universities and other research agencies in fundamental research on aerosols, gases, vapours and odours in connection with methods of measurement and prevention of pollution.
3. Training of municipal and provincial officers, and staff of other interested agencies, through organization of staff courses and symposia in sampling techniques, analytical procedures, instrumentation, organization and administration of atmospheric pollution activities, including regulation and control.
4. Maintenance of effective services to assist federal, provincial and other agencies in the study and control of atmospheric pollution as required.

4. National Air Sampling Network

A National Air Sampling Network is a fundamental requirement for investigations in the field of atmospheric pollution. With increasing growth of population and industry there is an urgent need to determine the basic concentrations of common contaminants in urban and industrial communities that may be consistent with good health. An answer is required to the question as to how clean the atmosphere must be maintained in order to be considered healthful.

City of Windsor showing locations of field sampling stations and areas (cross hatched) utilized in a health study.

A network system for the comparison of atmospheric pollution levels at key centres across the country along the lines of the current programme in operation by the United States Public Health Service is being organized through a cooperative effort with various municipal and provincial departments.

The accumulation of fundamental information on atmospheric pollution levels in correlation with meteorological factors throughout the year at a number of urban, industrial and rural areas across Canada, and the analysis of representative samples, would serve as the basis for studies having the following objectives:—

(a) Improvements in methods of measurement and chemical identification of contaminants.

(b) The biological effects of contaminants in animals and man under controlled experimental conditions.

(e) The effects of pollution on public health, vegetation and property.

(d) Criteria of air cleanliness.

(e) Improvements in regulation and control of pollution.

The actual maintenance of equipment and collection of samples for measurement of pollution levels may be undertaken by staffs of municipal, provincial and research agencies cooperating in this joint effort. However, assistance would be required from the Department of National Health and Welfare in overall direction, planning and continuity of the programme, in chemical analyses of selected samples as required, and in assessment of the data from the network of sampling stations. Standardized methods are essential for cross comparison of results and international agreement on a standardized approach would make it possible to compare the results with data now being gathered by the United States and by the Department of Scientific and Industrial Research in Great Britain.

It is anticipated that after the operation of such a network of sampling stations for some years, sufficient data would be available to provide guidance for planning of suitable epidemiological studies of the effects of air pollution on public health at one or more key urban or industrial centres. Improved methods of assessing morbidity might be applied to the studies of such key centres in the light of experience gained in health studies in the Windsor-Detroit area, Cincinnati and elsewhere. The environmental data would also be extremely helpful in statistical studies of specific types of mortality in relation to air pollution.

The results would be of great assistance in community planning and zoning, and in the evaluation of the effectiveness of provincial and municipal ordinances and regulations dealing with the control of atmospheric pollution. As more knowledge is accumulated on the variations in concentration of contaminants within cities and at distances from such multiple sources in relation to wind speed, direction, turbulence, lapse rate and other factors, it should be possible to predict pollution levels and occurrence of smogs in much the same way as in weather forecasting.

Measurements and Data

The routine maintenance and operation of equipment at the selected stations, including collection of samples in relatively high and low pollution areas, will be performed by municipal, provincial or other staff cooperating in this network survey on a voluntary basis. Departmental staff from the Occupational Health Division would be prepared to assist in the analysis and identification of samples of particulate matter, gaseous and vapour contaminants.

The following measurements of pollution levels are desirable at each location:—

1. Particulates

a. Coarse particulates or fallout.

b. Aerosols or air-borne particulates, including fumes and mists.

2. Gases

a. Sulphur dioxide.

b. Other gases such as oxides of nitrogen, volatile fluorides, oxidants, hydrogen sulphide, aldehydes, carbon monoxide, etc. as required.

3. Vapours and Odours

a. Hydrocarbons and other volatile organic compounds.

b. Odour nuisance compounds.

Basic Instruments and Equipment

1. Particulates

a. Standard deposit or dustfall containers.

b. High volume filtration sampling apparatus for suspended particulates.

2. Aerosols

a. A standardized continuous sampler to yield a 2-hourly spot record, of about one inch diameter, of filtered aerosols on a moving paper tape.

b. A smoke photometer for the evaluation of aerosol concentrations by light scattering technique.

3. Gases

a. Standard, lead peroxide coated, cylinder for evaluation of mean sulphur dioxide concentration. (D.S.I.R. specification).

b. Thomas conductivity or other types of automatic analysers for continuous determination

of acid gas concentration levels, (at key stations only.)

c. Specific collection equipment for analysis of oxides of nitrogen, fluorides, hydrogen sulphide, oxidants, carbon monoxide, aldehydes, etc., as required.

Analysis and Evaluation of Samples

1. Fallout or Dustfall

a. The total weight, insoluble and water soluble components of collected material are evaluated in terms of tons/sq. mile/30 days or lbs/1000 sq. ft./30 days. The insoluble fraction is analysed for combustible matter, tar and ash. On the water soluble fraction, the pH is determined and also the concentration of anions such as sulphate, chloride and nitrate.

2. Suspended Particulates and Aerosols

a. The total weight of the filtered material collected by the High Volume Sampler at a measured airflow rate over a minimum period of 24 hours is determined and the result is expressed in micrograms per cubic metre of air at N.T.P.

b. The transmission of optical density of 2-hourly spots or stains on the filtertape of the Spot Sampler is determined in a photoelectric colorimeter at about 440 mμ (using appropriate light filters.) The air sampling rate is maintained constant at about 0.25 cubic feet per minute or about 30 cubic feet every two hours. It is usual to express the results in Coh units per 1000 linear feet of air sample.

3. Sulphur Dioxide

a. Lead Peroxide Cylinder.
The coated lead peroxide fabric is stripped off the cylinder after one month exposure and the area of the peroxide surface is measured accurately. By chemical analysis, the weight of sulphate accumulated during exposure is determined. The results are then expressed as milligrams of SO_3 per day per 100 sq. cm. of lead peroxide surface.

b. Continuous Analyzer
The strip chart record from the conductivity analyzer is evaluated in terms of sulphur dioxide concentration in parts per million (p.p.m.) of air by volume over 30 minute periods of the day according to standardized techniques.

Correlation of Data and Assistance in Special Duties

In order to correlate the data from all stations of this network, it is considered essential that copies of observations and reports of analyses should be submitted to the Department of National Health and Welfare at periodic intervals, together with meteorological records of wind direction, velocity, temperature, humidity and precipitation available from the Dominion Weather Stations contiguous to sampling sites.

Samples that cannot be evaluated properly at Municipal or Provincial Laboratories may be shipped to the Occupational Health Division of this Department for further study and analysis. Equipment of a complex character should only be installed at stations where properly trained staff is available for maintenance.

For a more complete examination of samples from network stations, the following studies may be performed in this Department if facilities are not available elsewhere.

Deposited Solids or Air-borne Particulates

a. Soluble organic fraction by solvent extraction.

b. Non-combustible fraction or ash.

c. Analysis for metal components.

d. Analysis for anion components such as chloride, fluoride, nitrate, sulphate and carbonate.

e. Infra-red absorption of organic fraction.

f. Determination of radioactivity levels.

The National Air Sampling Network will provide material for special research into the nature and composition of the complex mixture of substances that find their way into the community atmosphere. Techniques for separation and identification of gases, vapours and aerosol components may involve the following studies and procedures with equipment available in this Department.

a. Separation of soluble components by liquid or gas chromatography followed by identification of specific compounds by means of ultraviolet or infra-red spectrometry.

b. Collection of gas and vapour contaminants by freezeout methods with subsequent separation and analysis of components.

c. Identification of major contaminant sources by special techniques, such as those employed in x-ray diffraction, infra-red absorption and electron microscopy. Carbonaceous combustion products may be differentiated as to biological or fibre, and fossil origin by determination of the ratio of ordinary carbon to radioactive carbon-14.

Selected species of indicator plants are useful in the diagnosis of damage and identification of sources giving rise to sulphur dioxide, fluorides and other halogen compounds, oxidants from the photochemical interaction of hydrocarbons and oxides of nitrogen, ethylene and illuminating gas, and other toxic wastes.

THE COLLECTION AND ANALYSIS OF AIR POLLUTION

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An old English recipe for jugged hare starts with the instruction "First catch your hare...".

In air pollution, the first problem is certainly to obtain a sample of the pollutant. In a few cases this is a simple matter of filtration or absoprtion, but in most cases considerable research is necessary before a usable sample can be obtained.

The collection of fall-out dust (as opposed to solid aerosol particles) is a simple, if somewhat slow, process. Where quantitative determination of the fall-out rate is required, the collecting can automatically give a sample adequate for most purposes. However, the collection efficiencies of the various pots and cans used can vary considerably, and the dustfall rate obtained is only comparable with data from other collectors of the same shape[1]. The Air Pollution Control Association has put forward a tentative standard type of collector and schedule of procedure which should do much to produce comparable date[2]. Among the other techniques developed are the use of greased plates which are widely used to check for decomposition of metal particles and Scotch tape which has been used when microscopic examination only is required. To collect samples of smokes or aerosols, filters or precipitators are usually employed. Filtration units are conveniently divided into two classes, namely, the high volume and low volume samplers. The high volume sampler, which, as its name implies, filters large volumes of air (about 3000 m^3/day) over a considerable period of time, collects a useful sample of one half to one gram of the aerosol on a filter medium.

The original units were developed around the small vacuum cleaner motor and impeller, but, although this mass-produced unit is cheap and readily available, it is not a satisfactory power unit for a sampler required to run continuously. Errors in air-flow rate due to leaks in the casing and extensive T.V. interference are other failings of the unit. Recently, a unit powered by a ¼ H.P. induction motor has become available[3] and maintenance problems have been reduced. The collection of a large sample of aerosols required a large area of low pressure loss filter. For quantitative work, the M.S.A. pleated filter is widely used, but, since the paper is heavily loaded with fillers, it is of less value where uncontaminated samples are required. A fibre glass paper is rapidly gaining favour for analytical purposes[4] since considerably more reliance can be placed on the analyses of the components. Another medium attracting considerable attention at this time is the Millipore filter. This is not a filter in the normal sense of the word, but a sieve giving a reasonably sharp cut off and high efficiency at ½μ, and holding the collected material on the surface for easy removal.

These dusts, as collected, are a mixture of many materials. Usually the first stage in the analysis is to determine the amounts of water-soluble, acetone-soluble and insoluble components. In the case of dust-can samples, these are most often received wet (since the can is usually kept wet to help retain the dust,) and the water-soluble component is found by filtering and evaporating the aqueous solution. Where the dust is received on a filter paper, it is usual to float off the sample by agitating the filter medium in alcohol (methylated spirits), followed by evaporation of the alcohol, and extraction with water. The sample is next extracted with an organic solvent to determine the tar fraction and we have found acetone to be satisfactory as well as non-toxic.

At this stage, the sample can be examined under the microscope and many components, coal, coke, quartz, pollens, and fibres, can be recognized. Metal particles and crystals are often removed at this stage for identification by X-ray crystallography, refractive index, or by micro-chemical tests carried out on the stage of the microscope. Finally, the residue of the sample is heated in a muffle furnace to determine the non-volatile non-combustible residue.

The low volume sampler[5], which collects the aerosol or a filter medium for quantitative assessment in terms of light transmission or other physical property of the exposed filter paper, can only give further data by microchemical methods, and is not recommended for chemical analysis except in special circumstances.

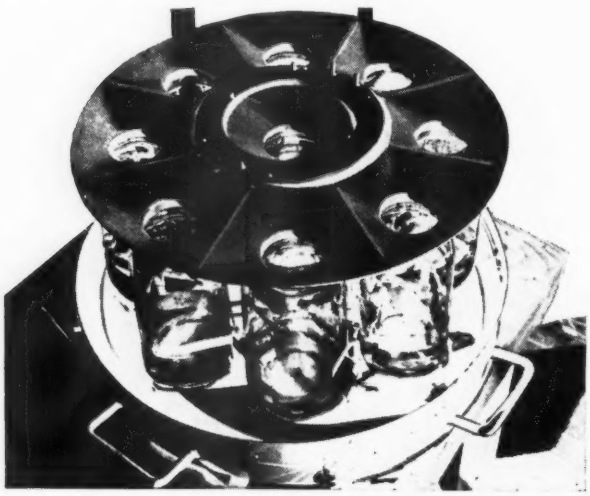
Portable electrostatic precipitation units working on the same principle as the Cottrell precipitator, and using an electrostatic attraction to cause the particles to precipitate on an earthed plate, are widely used where samples free from filter media are required. The thermal precipitator also gives samples free from filter media, but the sample rate is considerably lower and the amount of sample collected is suitable only for microscopic examination; in fact, it is usual to precipitate the sample directly on a microscopic slide. The impinger and micro-impinger are widely used in hygiene work and in cases where particle counts in millions of particles per cubic foot are required. The pollutant is obtained either on a slide or dispersed in a medium and the amount collected is usually insufficient for chemical examination. More recently, the increasing interest in the role of aerosols in lung diseases has resulted in the development of automatic particle counters, electronic devices which can count the number of particles passing in an air stream and classify the particles into ten size groups.

The instruments described above represent the stock in trade of the pollution laboratory in most of the cities of the world. Their primary interest is in particulate pollution, either smoke and fly ash from boiler and furnaces, or metal particles from metal refiners, foundries, and engineering shops. The only other pollutant of traditional interest in these industrial areas is sulphur dioxide. So far, three satisfactory methods have been developed for sulphur dioxide and are in use to-day. The first is essentially a spot check in which the air is scrubbed[6] and sulphur dioxide is measured by iodometric titration. This method requires a minimum of special equipment and experience but is wasteful of man power. The second method, widely used in Britain, gives a measure of the average sulphur dioxide level over a period of about a month[7]. A cylinder of lead peroxide is exposed to the atmosphere for several weeks, at the end of which time the total sulphate present is measured. The results are given in grams of sulphate per square metre of surface per month. It is not possible to convert the data to sulphur dioxide concentrations with any degree of confidence since with a constant sulphur dioxide level, the values obtained are influenced by temperature, wind velocity, and humidity. It is claimed, however, that the value obtained is a function of the SO_2 reactivity rather than concentration, and that the result correlates well with the corrosion potential of the air. The third method, which is widely used in North America, is the continuous recorder developed by Dr. Thomas and known by his name[8]. This machine records automatically the change in conductivity of a sulphuric acid-hydrogen peroxide solution when a SO_2 –air mixture is passed through the absorber. The SO_2 dissolves and is oxidized to SO_3; the conductivity cells sense the increase in conductivity and record continuously the SO_2 concentration in parts per million. Some instruments also have a collecting vessel to retain the aspirated solution for a period of half an hour and the record includes half-hourly average concentrations.

These instruments covered the field of traditional air pollution problems. However, in recent years, the problem of the sooty, smoky atmosphere over large cities and manufacturing centres has been joined by the new problem of pollution in the relatively smokeless areas wherein petroleum products, plastics, detergents, rubber, etc., are made and processed. In low concentration, pollution in these areas forms a white haze which, as the concentration increases, gives rise to eye irritation. Certainly, this pollution has a noticeable effect on vegetation[9], and there is much speculation concerning the effect on human health.[10]. At any rate, much research work is being carried out and a great deal is being done to develop new sampling techniques. The concentration of individual components is quite low, usually of the order of 10-100 parts per billion,

Directional Dust Fall Collector developed by Battelle Memorial Institute, Columbus, Ohio, U.S.A.

although occasionally concentrations of the order of a few parts per million may be encountered. Analysis for individual components, therefore, depends almost entirely on scrubbing (or by some other means contacting) large volumes of air with a reacting solution. The collected pollutant may then be determined by titration, but more often colorimetric methods are used. Among the compounds determined by these methods, we may mention the use of lead salts for the estimation of hydrogen sulphide[11]; the estimation of oxides of nitrogen by Saltzman's reagent[12], of chlorine by o-toluidine, of ozone by buffered potassium iodide[13], of oxidants by phenolphthalin[14], and of carbon monoxide by iodometric titration of iodine released from iodine pentoxide[15]. In some cases, where colorimetric measurements can be employed, a continuous flow of reagent is passed through the cell and the photo-tube response is recorded on a chart. In this way, records of the concentration of oxides of nitrogen, oxidizing agents and chlorine have been developed. These methods have been used extensively in the Los Angeles area. Unfortunately, many of the reactions utilized in these colorimetric determinations are by no means specific. Thus, both potassium iodide and phenolphthalin were used to determine the ozone content of the air. The continuous discrepancy between the two estimations indicated that the phenolphthalin (and possibly the KI method also) is affected by oxidants other than ozone. To overcome these shortenings, increasing use is being made of spectroscopic methods to analyse specifically for components. Already the presence of ozone in Los Angeles air has been proved conclusively and the concentration measured by spectroscopic means. Even more recently, an instrument having a light path of 500 metres within the gas cell has been constructed to examine materials existing at concentrations of less than 1 p.p.m.



Details of Directional Dust Fall Collector.

The work of Haagen Smit and others, proving that under the influence of sunlight, reactions between pollutants continue in the atmosphere, has raised the problem of identifying the reaction products. Whereas the determination of the concentration of a known component can be accomplished by scrubbing a large volume of the atmosphere with a specific reagent, the collection of unknown compounds presents some difficulty. Adsorption on active charcoal or silica gel has been used successfully in collection of samples of water pollutants and is being tried for air pollutants. Difficulty in recovery of the collected sample and the possibility of inter-reactions on the surface of the charcoal or gel limit the use of this material. For many years, freeze-out trains have been used with good results provided an efficient filter is incorporated in the trap. Without a filter, the pollutants are frozen to a snow which sweeps through the trap and re-evaporates in the atmosphere again. The liquid oxygen freeze-out trap has been widely used in the collection of samples of smog in the Los Angeles area, where the major advances in this field of endeavour have been made in the past ten years.

This brief summary does little more than indicate the techniques found most satisfactory in operation. Air pollution sampling is undergoing vigorous development and techniques developed in biological and other branches of science are anxiously being explored to assist in the analysis of pollutant samples; samples ranging down to fractions of a microgram and up to complex mixtures of a hundred or more components. Analysis of air pollutants is not a science; it is a hodge-podge of techniques collected from other sciences, modified and adapted to solution of some of nature's most complex problems.

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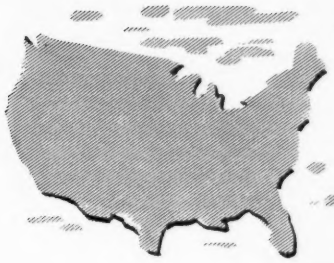


*THE PRESENT STATUS OF ATMOSPHERIC POLLUTION IN THE UNITED STATES

Report of Committee on Air Hygiene, Engineering and Sanitation Section

Harold A. Whittaker, Chairman

Gordon M. Fair, Sol Pincus, Frank Princi, Arthur C. Stern, Harry Wexler, Walter Purdon

Advisers

Alexander D. Langmuir, Stuard Mudd, Constantin P. Yaglou

Three kinds of measurement may be applied to air pollution in attempting to survey its present status in the United States. These are measures of (a) public attitude toward polluted air, (b) effects caused by polluted air, and (c) the pollution itself. The information sought is (a) where in the United States is air pollution a problem; (b) what is the intensity and significance of the population in these several areas; and (c) what is the intensity and significance of the several kinds of pollution. There is, in addition to the foregoing, the need in a status report to survey what is being done to learn more about air pollution and what is being done to control pollution.

Public Attitude Toward Air Pollution

Public attitude toward air pollution may be reported in two ways, by recording where such attitude has been made evident through (a) news stories about local manifestations of air pollution, and (b) the support of local air pollution control agencies created by the public for their self-protection.[1] As would have been expected, there is a close parallel between the distribution of populous urban communities and air pollution problem areas. In other words, to get a good map of major air pollution problem areas, one may map the location of the larger metropolitan complexes.

It is, of course, recognized that problems may exist in communities too small to support a newspaper or a control agency, thereby escaping recording by the indices employed. However, there is a means for bringing such situations to light. This means is the intensive survey. An insufficient portion of the country has, as yet, been subjected to this technique to provide direct data on the location of problem areas. However, intensive studies of several states have been completed during the past year and several more are in progress, so that in the not too distant future, we hope to be able to combine the findings of a number of intensive state-wide surveys into a more realistic estimate of the extent of the air pollution problem of the United States.

Effects of Air Pollution

Some classes of effects of air pollution are, at present, largely unreportable because of lack of data. The most important item in this category is the chronic effect of air pollution on human health. Another is the effect of air pollution on visibility. Both of these, however, are under study; the former principally by research studies supported by Public Health Service research funds, the latter principally by those concerned with airport and flight visibility.

Objective studies of damage by air pollution to materials require many years of atmospheric exposure. It is therefore fortunate for our purposes that a twenty year study of atmospheric corrosion of metals has just recently been completed and reported. Although much of the corrosiveness of the atmosphere is due to pollutants of natural origin (i.e., sea salt, sand, and soil), one can readily detect the influence of man-made pollution on the relative corrosiveness of the several atmospheres reported.[2]

Our knowledge of the geographic distribution of areas where air pollution is causing significant damage to vegetation and livestock suffers from both incomplete reporting and doubtful diagnosis. With these important qualifications, the major pollution areas known at present are categorized.

Composition of Air Pollution

Measurements of total pollution and of pollution components are available from all parts of the United States. There are measurements of settled solids mainly from northeastern cities; oxidants, ozone, oxides of nitrogen and other gases mainly from the Southwest; fluorides in most part from the Northwest; and sulfur dioxide from scattered locations. While these data in

*Presented before the Engineering and Sanitation Section and the Conference of Municipal Public Health Engineers on Tuesday, November 13, 1956 (Annual Meeting of The American Public Health Association, Atlantic City, New Jersey).

total represent a tremendous resource of information about the contamination of our atmosphere, they are, on the whole, too spotty to allow region-to-region comparison.

The only type of datum now being obtained on a uniform basis throughout the United States is suspended particulate matter, which is being measured by a network of cooperating local, state, and Federal agencies. It should be noted that negotiations for inclusion in the Network are under way with sufficient additional communities that by January 1, 1957, there will be a sampling station in every major metropolitan population center in the United States, with at least one such station in each of the forty-eight states, in two territories, and in Puerto Rico. The nonurban sampling sites have been chosen to give background levels in unpolluted ocean, gulf, and Great Lakes coast sites; mountain, desert, forest, and farmland sites. Eventually, there will be one nonurban site in each state, but this objective will not be reached by the start of 1957.

Local Air Pollution Surveys

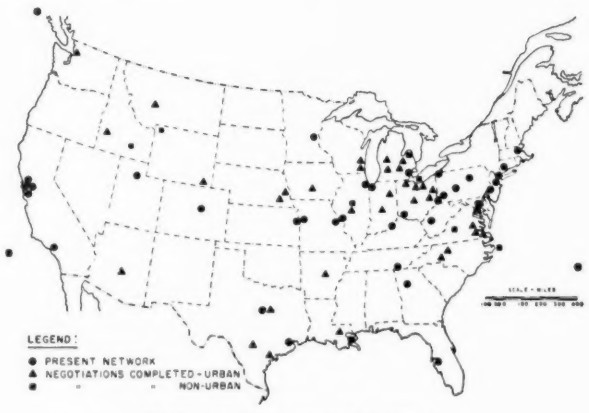
The number of communities now under study by local air pollution surveys involving more or less intensive air sampling and analysis is at an all time high. Surveys of this sort may be expected to increase still more next year because of the availability this fall of the initial Public Health Service Grants-in-Aid to States and Communities for Special Demonstration Projects.

The technique of conducting an air pollution survey is being critically evaluated because the cost of automatic instrumentation and data reduction to measure "everything" that may possibly be of interpretative value has tended to price the air pollution survey out of the market. If we want to continue to study air pollution in cities, it is imperative that we find methods and equipment that we can afford to use.

Professional Training

An important measure of the current status of air pollution is the present availability of at least five university curricula designed for graduate training for Master's degree with specialization in air pollution, namely, at Harvard, Rutgers, California, Cincinnati, and Florida.

With the inauguration this fall of the Public Health Service Grants-in-Aid Program for university air pollution graduate curricula, still more schools may be in a position to offer this type of training next year. An additional reason that this may be possible is the anticipated increase in the number of applicants for such training as the result of several factors: increased awareness of professional opportunities in air pollution; increased need for trained people by industry, universities, and government; and, lastly, an increase in the number and value of the fellowships available to support students for advanced air pollution training. These fellowships have been made available mainly by the Public Health Service, both as general public health fellowships and as fellowships specifically for air pollution training.



National Air Sampling Network.

At the risk of unduly emphasizing the Public Health Service role in air pollution training, attention must be directed to the short-term training courses of the Robert A. Taft Sanitary Engineering Center, a program now entering its second year. During the first year, 5 courses were offered, and 287 persons were trained in the chemical, physical, meteorological, engineering, or administrative fundamentals of air pollution. The current year's offerings include all these subjects, plus some new courses in agricultural and industrial aspects of the problem.

Literature Resources

The expansion of training has fortunately been accompanied by the advent of several new text books, bibliographies, abstracting services, reference manuals, and training aids to help make the training task possible. The texts include the "Air Pollution Handbook,"[3] edited by the group of workers in air pollution at Stanford Research Institute and the Proceedings of the First International Congress on Air Pollution (New York City, March 1-2, 1955) sponsored by the Committee on Air Pollution Controls of the American Society of Mechanical Engineers, and edited by the Committee's Executive Secretary. These Proceedings were published under the title, "Problems and Control of Air Pollution".[4] Several chapters in the "Air Pollution Abatement Manual"[5] of the Manufacturing Chemists Association have recently been revised and brought up to date. The first report of the American Petroleum Institute Dust Collector Project Subcommittee — the report on Cyclone Dust Collectors[6] — has been

published, and work has started on similar reports on the other dust collector types. The handbook, "Meteorology and Atomic Energy", prepared by the Weather Bureau and available from the Government Printing Office, actually covers the more general subject of meteorology and air pollution.

The manufacturing Chemists Association Manual contains a comprehensive air pollution bibliography based upon the excellent bibliography compiled by Stanford Research Institute. Another bibliography independently prepared by the Bureau of Mines is obtainable through the Government Printing Office.[7] Both these bibliographies are being currently supplemented and kept up-to-date on a monthly basis by two abstracting services; the one, which provides the abstracts on 3x5 inch cards indexed for subject, title, and author filing is conducted by the Library of Congress (under contract from the Public Health Service); the other, using 8½x11 inch sheets punched for filing in a loose-leaf binder, is provided by the Air Pollution Control Association.

Among the more important recent technical resources in air pollution are the series of reports of the Air Pollution Foundation,[8] the Proceedings of the three National Air Pollution Symposia[9] held in Pasadena (California) in 1949, 1952, and 1955; the Proceedings of the Air Pollution Control Association, and its JOURNAL (formerly AIR REPAIR); and the AMERICAN INDUSTRIAL HYGIENE ASSOCIATION QUARTERLY. SMOG NEWS, a biweekly news bulletin providing a national cross-section of newspaper stories relating to air pollution, is provided by the Committee on Air Pollution Controls of the American Society of Mechanical Engineers. Local Newsletters are issued regularly by the air pollution control agencies in Los Angeles County and New York City. Newsletters are also issued periodically by the Air Pollution Control Association and the Air Pollution Foundation.

Public Information Programs

The outstanding national educational activity in air pollution is the "Cleaner Air Week" program promoted by the Air Pollution Control Association. This year the local programs during Cleaner Air Week have been more impressive than in any previous year, being featured by radio, television, and newspaper offerings to bring the "why" of air pollution to the general public, and by technical meetings to bring the "how" of air pollution control to the technical and industrial public. In contrast to this one-week-a-year national effort, the most impressive sustained year-round local public educational program is that of the Los Angeles County Air Pollution Control District. The only two up-to-date films on air pollution both relate specifically to Los Angeles "smog". They were prepared for Stanford Research Institute and the Air Pollution Foundation, respectively.

Note should be taken of the large number of scientific disciplines involved in air pollution, as evidenced by the large number of professional, technical, and industrial organizations currently having air pollution committees. It is too soon to say whether this is a healthy or an unhealthy situation. It is most likely healthy in that no one organization is strong or inclusive enough in the field, at present, to exercise any restraining or confining influence on its development.

Technological Trends

It is axiomatic in this work that the quantity of pollutants emitted to the atmosphere over a community increases as the population of the community increases (as the result of both normal population growth and increased urbanization of the United States) and as the energy requirements per person increase. However, superimposed on these fundamental trends, there are others of shorter term which more immediately concern us. The most significant are the increase in the fraction of total energy requirements supplied by liquid gaseous fuels as compared to solid fuels[10] and the increased importance of industries which emit pollutants as gas and vapor rather than in the solid phase.

Despite this change in the character of pollution, our most impressive progress in the technology of emission control has been in the control of solid phase particles. Advance of the art of gas cleaning for removal of solid particles has been spectacular, particularly in the iron and steel industry. As a result, there has been a corresponding change in emphasis in pollution problems, from those involving solid phase emissions, to those involving gas or vapor phase emissions, which, among other things, has caused the partial obsolescence of municipal air pollution control legislation and enforcement practices based solely on the Ringelmann chart and fly-ash emission limits.

Support of Air Pollution Research

Elsewhere in this status report, there has been reference to the recent federal impact on air pollution education, surveys, and literature resources. This has been the result of the passage last year of the Federal Air Pollution Research and Technical Assistance Act (Public Law 159-84th Congress). These services fall within the Technical Assistance category along with the availability for the first time of Federal consultative help to state and local air pollution control agencies. However, equally important has been the enlargement of the air pollution research effort of the Nation as a result of Federal support last year of almost three quarters of a million dollars worth of such research in universities and research institutes, and of like

amount of support for air pollution research in the laboratories and field stations of the Bureau of Standards, Bureau of Mines, Weather Bureau, and Public Health Service.

A recent analysis[11] of the 271 known air pollution research projects in the United States indicates that, while this one and a half million dollars of Federal support has been significant, it still represents less than one-third of the total support for such research. Because this research effort is not concentrated in a few Governmental research centers, it tends to be conducted in the regions most affected by air pollution. As would be expected, the bulk of the projects are in universities and nonprofit research institutes. A similar analysis of research activity was prepared in April, 1956[14]. The general pattern is still sufficiently similar to allow the discussion prepared on that occasion to be repeated here, viz:

Kinds of Air Pollution Research

"As would be expected, all phases of the problem are receiving some attention. The distribution of attention among work areas, after making allowance for the fact that some projects cover more than one work area, shows greatest concentration on the environmental (chemical, physical, meteorological, and engineering) phases, and a lower level of activity in the biological (medical and agricultural) phases. This lack of concentration on biological phases may be unreal — a corollary of the fact that the solicitation of information was conducted by persons mainly interested in assembling information on the environmental and engineering aspects of the problem. There are most likely a substantial number of biological studies, not reported here, which are indirectly related to air pollution. Such projects include studies of the effects of trace elements and compounds upon crops and livestock, and the effects of a wide variety of substances on humans and on experimental animals.

"However, even if allowance is made for substantial under-reporting of biological studies in this compilation, the most significant finding is an apparent lag in biological air pollution studies with respect to other phases of the problem. Thus, if any guide to future activity is to be taken from this survey, it is that, to bring the over-all effort into better balance, there must be greater emphasis on those kinds of biological studies that will show what it is in the atmosphere that is harmful to animals, plants and people.

Projects Other Than Research

"The most desirable definition of air pollution research should limit it to those studies which, regardless of location of the study, yield results equally applicable anywhere. This definition was not used in this report. All air pollution studies immediately directed towards adding to the total store of air pollution information which were considered by those sponsoring or doing them to be research, were herein classified as research. This was the case even where the study involved only a single state, county, city, factory, or stack. It is believed that the same criteria were applied to the previously noted 1955 and 1953 surveys. Hence, the data from this tabulation should be comparable with them. The argument as to what is or is not research is both fruitless and never-ending. However, to satisfy the purist, it may be estimated that about 20 per cent of the projects herein reported will not stand up as research under the definition at the beginning of this paragraph. It should also be recognized that there is unquestionably an under-reporting of field studies, since little of the work of cities and of individual contributors to air pollution, in quietly studying their own problems, ever gets reported in tabulations such as this.

Location of Agencies Conducting Air Pollution Research October, 1956.

"In reviewing an expanding field such as air pollution research, there is a temptation to complacency. Complacency is not justified because most of the present activity is attributable to the support of only a handful of sponsors. In the present state of development, withdrawal of the support and interest of these few sponsors would be disastrous. The job that needs to be done is much, much bigger than what we are now doing. To get the answers we need, the present sponsors must not only continue their support, but must increase it; and new sponsors must be shown the urgent need for continuity and expansion of the present research effort".

Foreign Developments

Although this status report is mainly limited to developments in the United States, a few other developments will be noted here. United States participation

in joint studies with Canada on air pollution along the Detroit River has continued, and the joint voluntary smoke control program which was continued through the past shipping season will likewise be continued next year by mutual agreement of both the shipping interests and the governments of the two countries.

The Air Pollution Standards project of the Canadian Standards Association is bound to make its influence felt in the United States. We may soon see the wisdom of following this example through use of the American Standards Association for similar and coordinated activity.

The foreign development most likely to influence air pollution activities in this country is the European network of stations for chemical analysis of rain water[15]. Supplementation of this network by a corresponding one on the North American continent may yield valuable information on the relative significance of man-made and natural pollutants.

Conclusion

More attention is being paid to air pollution in the United States than in any previous time in our history. However, the magnitude of the problem is growing pace with our increased attention to it. As a result, we are just about keeping up. To move out ahead and lick the problem, more stenuous efforts are needed.

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MANUAL ARTIFICIAL RESPIRATION

(In the sitting position)

In a recent issue of the Lancet, Dr. H. Ruben published an article on artificial respiration in the sitting position.

This method is intended for use in cases where a patient stops breathing while sitting in a chair, or when it is necessary to apply artificial respiration in a confined space where it is impossible to place the victim in the prone or supine position.

Method (Both inspiration and expiration are actively produced).

Position of operator — either in front of or beside the patient.

Position of patient — Flex patient's body forward so that the head and trunk are close to the legs.

PROCEDURE

Expiration — Apply pressure with the hands to the back, about the level of the shoulder blades. This action serves to compress the abdominal contents thus forcing the diaphragm upwards and forcing expiration of air from the lung.

Inspiration — Release pressure of hands, allowing chest to expand passively to its normal resting position. Promote inspiration by lifting the trunk thereby decompressing the abdominal contents and allowing the diaphragm to descend.

How to Lift Trunk — If the operator is standing in front of the patient, he can place his hands, one under each shoulder, and lift the upper part of the body. If standing to one side, he can place one hand in the axilla nearest him and the other hand over the opposite shoulder. Depth of inspiration is increased by lifting the trunk until the spine is sligthly extended, a procedure which increases the capacity of the thorax.

Timing — about 12-15 completed cycles per minute.

Precautions — See that the tongue is forward and the mouth clear.

Advantages — No preparation is required. The tongue falls forward, or can be easily made to do so. Fluid contents of mouth and throat will move forward out of the mouth and the mouth cannot be obstructed. During the expiratory phase the viscera not only press on the diaphragm but also on the vena cava, possibly helping venous return to the heart.

An effective exchange of air is produced by this method.

THE RESPONSIBILITIES OF THE MEDICAL PROFESSION IN THE USE OF X-RAYS AND OTHER IONIZING RADIATION

Statement by the United Nations Scientific Committee on the Effects of Atomic Radiation

I. INTRODUCTION

1. The United Nations General Assembly, being aware of the problems in public health that are created by the developments of atomic energy, established a Scientific Committee on the Effects of Atomic Radiation. This Committee has considered that one of its most urgent tasks was to collect as much information as possible on the amount of radiation to which man is exposed today, and on the effects of this radiation. Since it has become evident that radiation due to diagnostic radiology and to radio-therapy constitutes a substantial proportion of the total radiation received by the human race, the Committee considers it desirable to draw attention to information that has been obtained on this subject.

2. Modern medicine has contributed to the control of many diseases and has susbtantially prolonged the span of human life. These results have depended in part on the use of radiation in the detection, diagnosis and treatment of disease. There are, however, few examples of scientific progress that are not attended by some disadvantages, however slight. It is desirable therefore to review objectively the possible present or future consequences of increased irradiation of populations which result from these medical applications of radiation.

II. GENERAL SURVEY OF THE IRRADIATION OF HUMAN BEINGS

3. Man has always been exposed to some irradiation from natural sources. To this have now been added, as a result of modern discoveries and the applications of ionizing radiation and radioactivity, certain forms of artificial irradiation.

4. Natural irradiation is due to:

(1) Cosmic radiation,

(2) "Background" gamma radiation from radioactive substances present locally in the earth, rock or building materials, and from disintegration products of radon in air.

(3) Radiations emitted from natural radioelements such as potassium 40, radium, radon and carbon 14 which are incorporated in the body.

5. The amount of this natural radiation varies with locality, but has been estimated as usually delivering between 70 and 170 mrems per year to the gonads. Of this total, the major contributions are of about 45 per cent from local gamma radiations, 30 per cent from cosmic rays and 20 per cent from body potassium 40.[1]

6. *Artificial irradiation* is derived from:

(1) The contamination of the environment, the atmosphere, or water by radioactive waste from atomic industries or from users of radioelements;

(2) The radioactive fallout, at greater or lesser distances from the source, or radioactivity resulting from the explosion of nuclear devices;

(3) The occupational exposure of certain groups of workers: medical practitioners, radiologists, dentists, nurses, atomic energy workers, uranium or thorium miners, and the industrial or scientific users of radiation generators or radioactive isotopes;

(4) The medical use of X-rays, other ionizing radiations and radio-elements in the detection, diagnosis, investigation and treatment of human diseases;

(5) The use of certain devices which emit radiation, such as television receivers, watches with luminous dials, and the X-rays generators used for the purpose of fitting shoes.

1. From reports sent by India, Sweden, the United Kingdom and the United States of America.

7. The amount of artificial radiation must vary considerably in different countries and we have inadequate information as to the over-all significance of these factors. In certain countries where estimates have been made, it appears that the greatest gonad irradiation of the population is due to diagnostic radiological procedures, the amount from this source about equalling that from all natural sources in certain instances. The total present contribution from occupational exposure from the products of atomic industries, from radiotherapy and from the radiating devices mentioned above (paragraph 6, sub-paragraph 5) is likely to be very considerably smaller. That from radioactive fallout to the gonads appears at present to be in the region of 1 per cent of the natural gonad irradiation in most areas.[1]

8. Both the magnitude and the significance of these various sources are under review by the Committee. Since medical irradiation accounts for a substantial if not the major proportion of all artificial exposure, it is important that its magnitude should be known accurately for different countries and circumstances. The possibility of making such an assessment depends upon the help of the medical profession, and particularly on the adequacy and availability of records kept by doctors, dentists and organizations responsible for the use of ionizing radiation.

III. RADIATION HAZARDS

9. The medical use of radiation is clearly of the utmost value in the prevention, diagnosis, investigation and treatment of human disease, but the possible effects of this irradiation of individuals require examination.

10. Generally speaking, the irradiation of living beings may produce radiobiological effects either on the irradiated individual himself or, through him, on his descendants; the former being termed somatic and the latter genetic effects. Somatic effects vary according to the different organs or tissues affected, and range from slight and reversible disturbances such as cutaneous erythema to the induction of leukaemia or of other malignant diseases. The possible reversibility of the somatic effects of radiation received in small doses or at low dose rates encourages the belief that there are permissible doses of radiation which will not cause completely irreversible or significant somatic damage. The threshold for occasional somatic damage may, however, prove to be low. In the case of genetic effects, on the other hand, there may be no threshold. These effects increase with a frequency corresponding to the total amount of radiation received by the germinal tissues, and in the great majority of cases, are adverse.

11. Many other factors complicate the interpretation of radiobiological effects. The differences between whole and partial body radiation, between a single exposure and continuous irradiation, or between the effects of different types of radiation are still imperfectly understood. Biological differences in the radiosensitivity of various tissues, or of the tissues of people of different age or sex, obviously influence the nature of radiation hazards. It is clear, however, that any irradiation of gonads, and any substantial irradiation of other tissues, involve a chance of significant damage which requires assessment.

IV. GENERAL RECOMMENDATIONS REGARDING THE MEDICAL AND OCCUPATIONAL IRRADIATION OF HUMAN BEINGS

12. The Radiological Profession, through the International Commission on Radiological Protection,[1] has undertaken a valuable and responsible duty in defining maximum permissible limits of exposure for the main radiation hazards.

13. The establishment of these maximum permissible levels for those who are occupationally exposed to radiation depends on the view that there are doses which, in the light of our present knowledge, do not cause detectable somatic injury in the individual irradiated; and on the consideration that the number of individual concerned is small enough for the genetic effects on the whole population to be negligible. For the gonads, or for irradiation of the whole body, the levels are such as to exclude doses greater than 0.3 rem in any week or 3.0 rem in any 13 weeks, or a sustained irradiation rate greater than 5 rem per year. These values imply that no total dose of over 50 rem will have been received by the gonads by the age of

1. According to the reports sent by the United Kingdom and the United States of America.

1. See the report of the International Commission on Radiological Protection, published in the *British Journal of Radiology* — Supplement 6, of December 1954, in the *Journal Français d'électroradiologie* — No. 10, of October 1955, etc.

30, or of over 200 rem by the whole body by the age of 60, in any occupationally exposed person.[1]

As regards irradiation of the whole population, it is considered prudent to limit the average dose to germinal tissues from artificial sources to the order of magnitude of that received from all natural sources.

14. In considering the extent to which the population is irradiated for medical purposes, it is essentially the genetic hazard which is involved although it seems possible that in certain circumstances somatic injury may occur occasionally after low doses of radiation. Otherwise, the relevant dose is that indicating the mean gonad irradiation among the population as a whole up to the end of the average reproductive period.

15. The extent of such genetic irradiation from diagnostic procedures has been found to be equal to at least 100 per cent of all natural radiation in two countries[2], and that from a third equalled at least 22 per cent of this figure.[3] Even before obtaining more exact values for these and other countries, it is clear that the exposure can be substantial in countries with extensive medical facilities, and that it is essential to consider any ways in which this exposure could be reduced and in estimating the amount of reduction that might be expected from any such methods. In particular it would be valuable to know how much the radiation to the gonads could be reduced.

(a) by improved design or shielding of equipment,

(b) by fuller training of any individuals using radiographic or fluoroscopic equipment,

(c) by any local shielding of the gonads that is practicable, especially during abdominal or pelvic examination,

(d) by the use of techniques involving radiography rather than fluoroscopy when full information can be obtained by this means,

(e) by improvement of administrative arrangements designed to obviate unnecessary repetition of identical examinations of the same subject,

(f) by a general study of certain medical conditions such as that of peptic ulcers, to identify the circumstances in which the establishment of a radiological diagnosis has or has not a definite influence upon the treatment or prognosis given.

V. SUMMARY

1. The Scientific Committee on the Effects of Atomic Radiation established by the United Nations General Assembly accepts the view that the irradiation of human beings, and especially of their germinal tissue, has certain undesirable effects.

2. Information received so far indicates that, in certain countries (Sweden, United Kingdom, United States of America), by far the most important artificial source of such irradiation is the use of radiological methods of diagnosis and that this may be equal in importance to radiation from all natural sources. It is possible that such radiation may be having a significant genetic effect on the population as a whole.

3. The Committee is fully aware of the importance and value of the medical use of radiations but wishes to draw the attention of the medical profession to these facts and to the need for a more accurate estimate of the amount of exposure from this source. The help of the medical profession would be most valuable to make it possible to obtain fuller information on this subject.

4. The Committee would be particularly grateful for information through appropriate governmental channels on ways in which the medical irradiation of the population can be reduced without diminishing the true value of radiology in diagnosis or treatment.

1. See the report of the International Commission on Radiological Protection, published in the *British Journal of Radiology* — Supplement 6, of December 1954, in the *Journal Français d'électro-radiologie* — No. 10, of October, 1955, etc.
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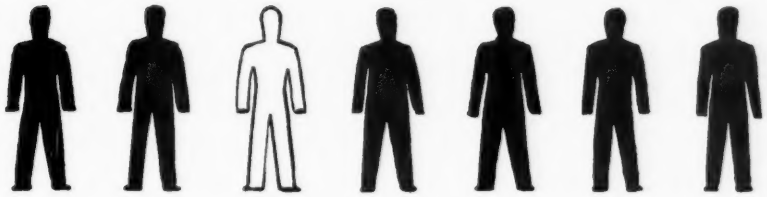
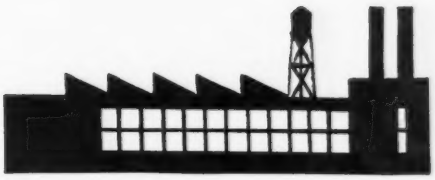
* THE PROBLEM DRINKER IN INDUSTRY





G. A. F. Wainwright, M.D.
Medical Director, John Labatt Limited, London, Ont.

The problem drinker in industry is one whose continued or repeated drinking interferes with the adequate performance of his work assignment. The term is preferable to its precursor "alcoholic" with its connotation of dissolution. The segment pertaining to his work situation constitutes only one part of the entity of his drinking problem.

Extent of the Problem

About two-thirds of the adult population use alcoholic beverages in varying degree. About one in twenty of these social drinkers develops some problem with his drinking. There are approximately 150,000 problem drinkers in Canada, of whom about 50,000 are in Ontario[1]. Most of these are employed. In industry their detection presents difficulties; a man may have a drinking problem and yet carry on efficiently in his work. So long as he performs adequately and his absenteeism is not great he does not by definition constitute a problem drinker. Depending upon the rigidity of the interpretation of the definition there is a marked variation in the figures submitted relating to the incidence of problem drinking in industry — from 6%, by estimation by the Jellinek Estimation Formula[2] to 3% revealed by other surveys. There is so much concealment and subterfuge resorted to, not only by the individual but by his family and friends in a misguided effort to protect the worker, that it is difficult to determine the actual extent of the problem.

Costs of the Problem

The cost to industry has been described as "Industry's Billion Dollar Hangover". Here, as with figures pertaining to the extent of the problem, only estimates can be made. The cost to industry per se is probably much less than the general literature would indicate. The task of industry is to produce goods for a profit in order to provide wages for its workers and returns for its investors. To accomplish this, production must be maintained at a constant level. The worker may be functioning below his potential without having this reflect in the output from a machine. If an employee directly concerned with production is absent, he is replaced by a worker from a reserve pool or from a "surplus assignment". Production itself is maintained at a very constant level. The short absences of three days or less, of which the problem drinker is guilty, usually are not covered by sick benefits and the loss reflects itself in the man's pay envelope, rather than in cost to the company.

Nevertheless, the hidden costs resulting from reduced morale, increased accidents and bad public relations, while difficult to assess, are not negligible. Alcoholism is now accepted as a public health problem and as industry carries a heavy tax burden the costs are reflected here. The expense involved in developing executives or skilled workers is often nullified by the problem drinker getting into difficulties at an age when his training program should give results. Certainly the increased absenteeism[3] (22 days per year in contrast to the average of 10 in industry) and the greater accident rate (twice that of the general frequency) result in a marked increase in costs no matter where these costs are assigned.

Portrait of the Problem Drinker in Industry

1. More than 80% are under 50 years of age; one out of four is under 35.
2. Over 50% are married and living with their wives.
3. Three out of four are living in established households.
4. Nine out of ten have lived in their present town for at least two years.

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5. Seven out of ten hold jobs involving special skills or responsibilities.
6. Nearly 60% have held steady employment on one job for at least three years and 25% for at least 10 years.

This portrait emerges from a survey conducted on 2,000 consecutive problem drinkers[1]. He is evidently not the itinerant worker, nor the skid-row derelict. His occupation status as determined by Archibald et al in an Ontario Survey is:

	%
1. Professional, managerial, proprietory	5.5
2. White collar	7.4
3. Skilled and semi-skilled	48.0
4. Unskilled	29.3
5. Transient or casual	6.3
6. Retired	3.5

He does not constitute a psychiatric entity although, psychologically, he has personality defects; he withstands tensions and frustrations poorly. He has high aspirations with limited accomplishments and tends to be controlled by his emotions rather than his intellect.

As yet, however, he cannot be identified by any means other than his alcoholic history. Physiologically he has a little understood defect by which having taken one or two drinks a craving results so that his drinking becomes compulsive.

Course of the illness

Alcoholism has been recognized by the medical profession as a disease for the past hundred years. The laity have been more reluctant to accept it as such. In his industrial area the problem drinker can usually be allocated to one of three categories. He may be a periodic imbiber who indulges in excessive drinking of a repetitive nature. Subsequently, he may become addicted to alcohol with evidence of loss of control of his drinking and an inability to break the habit. This, in turn, may progress to chronicity resulting in physical and mental impairment. The course of the disease in its entirety tends to conform to a pattern which is fairly constant. The disease shows seven phases — not always sharply delineated in stage or time. The problem drinker, as he relates to industry, does not participate in the later phases.

Phase 1—Social Drinking

The pattern shows little to distinguish the problem drinker from the social drinker, except in regard to the frequency and amount consumed.

Phase 2—Dependent Drinking

The problem drinker begins to indulge in excessive drinking for relief of tensions.

Phase 3—Increased Tolerance

He must consume more liquor to obtain the anaesthetic effects; he resorts to sneaking drinks and gulping drinks. Periods of amnesia (blackouts) characterize this phase.

Phase 4—Loss of Control of Drinking

He becomes dependent upon alcohol resorting to daily evening drinks and heavy weekend drinking. This is the phase marking the onset of the disease of alcoholism and personality changes are concomitant with it.

Phase 5—Rationalization

He ascribes various reasons for his drinking. He "goes on the wagon" for short intervals to prove his ability to do so. This progresses to morning drinking, solitary drinking and excesses obtruding into his work schedule. Personality changes become more evident and he experiences resentments, remorse and deep feelings of guilt. The fear of facing life without alcohol becomes intolerable. This phase usually marks the "point of no return" if he is not salvaged.

Phase 6—Phase of Fear

He now realizes that he must have help if he is to survive. He is prepared to accept hospitalization. Here he may resort to drugs to enable him to carry on.

Phase 7—Phase of Resignation

He resorts to continuous drinking with an acceptance of this derelict condition and its concomitants of organic disease and mental changes.

The disease tends to run its course in from fifteen to twenty-five years. The segment which constitutes

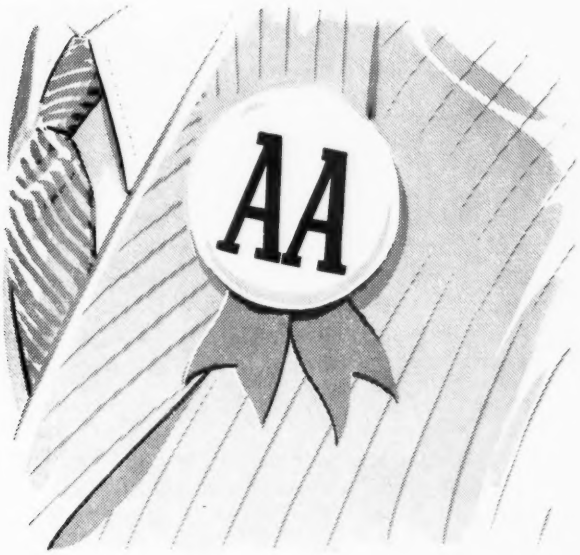
the industrial problem drinker involves phases 1 to 4 and usually extends over a period of twelve to fifteen years. By the time he has entered phase 4 he constitutes an industrial problem drinker about whom a decision must be made. If he is not rehabilitated here he does not continue in industry for he becomes unemployable.

Industry's Responsibility

Whether an industry adopts a program for the rehabilitation of the problem drinker or not, a policy should be formulated. The problem is divided into two parts:

1. The employment of an individual from whom a history of alcoholism has been elicited or who is known to be an alcoholic.
2. The disposition of an established employee whose drinking is becoming a matter of concern to the company.

The applicant who has lost a job because of a drinking problem should not be employed by the company until he has shown proof that he has done something constructive about his problem. Many alcoholics may ally themselves with A.A. merely to convince prospective employers of a sincere effort to deal with their problem. This subterfuge is usually not difficult to detect. A participation in the program for a period of one year and a contribution in helping others afflicted with the same illness preclude any ulterior motive.



Failing this he should be engaged in industry for a period of one year in a capacity in which his absenteeism or poor work performance will not disrupt work groups or team efforts; e.g., construction work. It requires a minimum of one year to effect a transference from alcohol. If the loss of a previous job or position does not point up to the individual that he cannot solve his problem without help, it is not wise to accept him.

It is true that some individuals solve the problem for themselves and, without outside assistance, recognize the fact that they cannot drink. This is such a rare occurrence, however, that industry is justified in requiring submission of evidence that this insight has been attained. In the later phase it is common for the individual who does nothing about his problem to gravitate to the type of job in which the work requirements do not conflict too much with his drinking habits.

What course should industry pursue with the established employee whose drinking reflects itself in his work assignment? The employer usually interprets the delinquent's problem in the light of his own drinking experience. He condemns him for lack of control and will power. The problem drinker is dealt with solely as a disciplinarian procedure. The action is usually contingent upon his length of service, his work performance apart from his drinking and the frequency of the episodes. If these determinants are in his favour he is usually warned once, twice or even three times and then is separated. Nor is this procedure to be condemned in its entirety. Not infrequently such a finalization indicates to an individual that he must assess his problem for himself; that he must admit to his inability to drink and, of his own volition, seek assistance.

However, this procedure does not recognize the potentiality of rehabilitating the alcoholic. Admittedly, he presents a difficult reclamation problem as he is inherently a recedivist. To be rehabilitated he must be prepared to recognize the fact that if he accepts help with this problem he is inviting recognition as a problem drinker with all its connotations. This is difficult for him to do. He has always resented any infringement on his right to drink and has steadfastly refused to relate his difficulties in any area including that of his work to his drinking activities. Management cannot "protect" the problem drinker. The problem is primarily his own; he must sincerely desire to terminate his drinking. He must appreciate the fact that from his past experience his reaction to alcohol differs from that of the social drinker and that he can never learn to drink "normally". He must learn that life without alcohol is more rewarding than life with alcohol. He must believe that if he is prepared to make a sustained effort he is quite capable of learning to live without alcohol. Industry has not reflected the interest in the problem that has been evidenced sociologically in the past ten years. Management today is very cost conscious. The employee must be presumed valuable enough to the company to justify the cost of his rehabilitation. The cost proves the stumbling block to the

institution of more industrial programmes — rehabilitation rarely produces an entry on the credit side of the ledger. Human relations in industry are being stressed today and until evidence can be submitted to management that salvaging the problem drinker is financially sound, the humanitarian approach must be resorted to.

Several companies in the United States and Canada have undertaken programmes for the rehabilitation of the problem drinker. Among these are the du Pont Company, the Allis Chalmers Company, the Eastman-Kodak Company, General Motors Corporation and the Bell Telephone Company of Canada. Some have recognized the condition officially as a medical problem and allow sickness indemnity and pension in selected cases. The majority of these programmes are modifications of the Yale Plan[5]— a flexible programme which is slanted towards:

1. The early recognition of the employee with a drinking problem.
2. The rehabilitation of the employee where it is justified.
3. The establishment of a consistent basis for termination when rehabilitation does not, from the company's viewpoint, appear justified.

Consultation Clinics

In 1952 Consolidated Edison volunteered to underwrite the cost of the Consultation Clinic for Alcoholism at the University Hospital of the New York University, Bellevue Medical Centre. This clinic is the first to be devoted exclusively to the problem drinker in industry. There are fourteen companies making referrals to the Clinic. Of these, two companies refer employees for appraisal to determine if rehabilitation is justified. Primarily, the purpose of the Clinic is to enable the referral to control his drinking to the point at which it does not interfere with his work situation. The broader aim, of course, is to rehabilitate the problem drinker in toto, not just as it pertains to the work area.

Of thirty-five patients referred by one company to the Consultation Clinic for alcoholism,[6] twenty were subsequently discharged by their companies because of further drinking episodes while they were on the probationary period during which they were undergoing treatment. None of these continued treatment at the Clinic subsequent to their discharge. The significance of this is evident. These referrals were primarily interested, not in the solution of a drinking problem, but in maintaining their jobs. One hundred and thirty-five of one hundred and eighty referrals from all companies who accepted treatment were able to control their drinking sufficiently well to maintain their jobs. However, of 23 problem drinkers who were referred, but refused treatment, 13 were able to retain their jobs.

The majority of the patients reported are in the older age group (45-60). In this age group drinking had become evident in the work situation. With them, motivation during probation was better because of increased difficulty in getting work if separated, particularly if they were dismissed as alcoholics.

Education Programmes

Education must be the precursor of any programme. Management and particularly the supervisory group must be taught the objective of the programme. The worker should be instructed in the early phases of the disease.

When a programme is first instituted, only the advanced cases are brought to light. The longer the programme is in effect, if it is successful, the more problems in the earlier phases will be revealed. The foremen or supervisory groups are best able to detect evidence of uncontrolled drinking. Frequent short absences, particularly after holidays and pay days, are significant. Personality changes resulting in bad inter-personal relations within the group should not be ignored. The medical departments should not be used in this case-finding programme. Any suspicion that information, imparted at a periodic examination or consultation, is subsequently disclosed to management, jeopardizes the reputation of the department and destroys the essential doctor-patient relationship. Any data pertaining to the problem released by the medical department should be sanctioned by the employee in writing.

Role of the Company Physician

The company physician should not be asked to function in a disciplinarian capacity although he should be accessible for consultation relative to the problem. It has been found more expedient for an industry to employ agencies outside, rather than within the industry. It is difficult for the employee to understand that his progress in the work environment is being viewed impersonally.

Bowman[6] states that we are not making satisfactory progress in the treatment of alcoholism. Certainly presently functioning programmes are not reaching the incipient problem drinker and figures[7] indicate that only a very small percentage of advanced cases are being detected and referred for treatment. There may yet be devised tests that will detect the incipent drinker as we now detect the incipient diabetic. In the meantime, we can still achieve a limited success with the various existing techniques and a defeatist attitude it to be condemned.

Duties of Management

Management should assess the employee; if he is considered to be worth salvaging, the issue should be faced squarely with him. He should be placed on probation with his retention being contingent upon his contact with a proper agency outside the company. Even though this motivation is extrinsic, it may still be effective. Whether or not be accepts treatment, separation is justified if his drinking, as it pertains to his work, is not, in the future, controlled. The institution of such a probation period may well act as a deterrent for early problem drinkers.

Most experienced workers in the field of alcoholism feel that the problem drinker cannot be helped unless he, himself, is motivated toward treatment. Usually, he has to experience some crisis or disaster to provide the motivation. In industry, the problem drinker has not usually experienced the later phases of alcoholism with which such crises are associated. Herein lies the value of placing him on probation; his retention in industry is contingent upon his control of his drinking, even though he may accept it with resentment.

Originally, the alcoholic was unreservedly condemned; he was considered to be completely lacking in willpower and moral fortitude. Subsequently, the pendulum swung to the other extreme and the alcoholic was considered to be a vehicle of psychological defects which precluded his ability to contribute to his own reclamation. A constructive attitude must present a compromise between these two extremes. His sucessful rehabilitation in industry should be facilitated by industry's recognition of the defects which distinguish him from a social drinker and the extension to him of an opportunity to do something constructive about his problem. If this extension takes the form of probation and referral to competent treatment facilities, then the humanitarian obligations are being met by industry. Given this opportunity, his final rehabilitation lies with the problem drinker himself.

Summary

1. The problem drinker in industry is one segment of the total picture of alcoholism. By definition, so long as his work is adequate and his absenteeism acceptable, he is not an industrial problem drinker.

2. Between 3% and 6% of industrial workers have a drinking problem which is reflected in the work situation.

3. The costs of the problem to industry itself are not greatly reflected in loss of production and increased wages. Hidden costs and the reflection in taxes however, make the problem significant to industry.

4. The problem drinker in industry is usually a responsible citizen. If his disease progresses into the late phases he does not remain in industry.

5. A problem drinker who has previously lost a job because of his drinking should not be employed until he has shown proof that he has done something constructive about his problem.

6. Programmes for the rehabilitation of the problem drinker in industry with particular reference to the Consultation Clinic for Alcoholism are discussed.

7. The treatment of the problem drinker in industry has not made satisfactory progress. From a financial viewpoint, a programme is not a sound investment for management. Management must be convinced that the undertaking is worthwhile from the viewpoint of human relations.

8. Industry can make a contribution by the introduction of a probation system with referral during probation to a responsible individual or group especially trained in this area. Given this co-operation by management, it is incumbent on the problem drinker to rehabilitate himself.

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